Unit 3 Review

Commercial Building

Land Use Planning (Urban Planning)

Planning for the long-term growth of an area

Purpose:

- Preserve public health, safety, and welfare
- Maintain compatible development within an area
- Provide adequate air, light, access, and open space
- Protect the natural environment and historic resources
- Minimize traffic congestion
- Enhance the streetscape and pedestrian environment

Regulated by municipalities

(towns, cities, counties)

Land Use Regulations

- Often called Ordinances
- May regulate a variety of aspects of development
  - Allowed uses on property
  - Building and lot size
  - Access to property
  - Parking lot designs
  - Setbacks
  - Landscaping
  - Many others

Zoning

- Most common form of land use regulation
- Zoning maps designate permitted uses of land tied to mapped areas
  - Residential
  - Commercial
  - Industrial
  - Conservation
  - Scenic
  - Recreational

Structures

Structure of a Building

The primary function of a building structure is to support and transmit the building loads and forces to the ground.

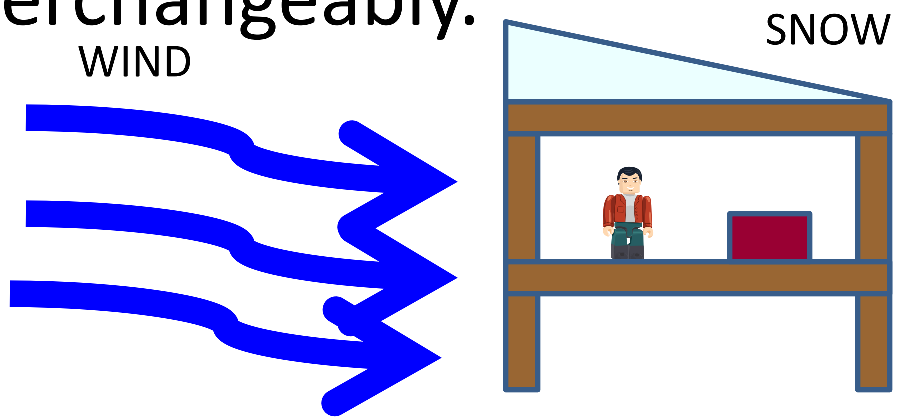
Photos courtesy Tilt-up Concrete Association

Characteristics of a Structure

- Strength
- Stability
- Economic Value

Forces and Loads

- A force is any action that causes a change in the shape or motion of an object.
- A load is a force that is supported by a structural element.
- The terms force and load are often used interchangeably.



Structural Engineering

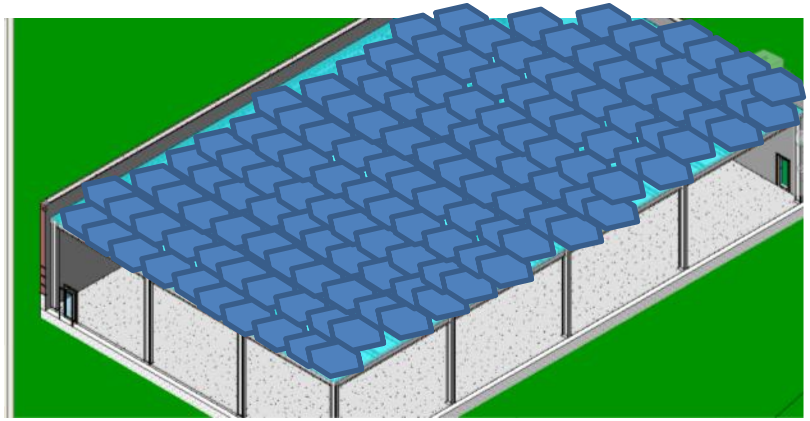
- Structural Engineering involves
  - the critical analysis of forces and loads
  - the anticipated effects of these loads on a structure
  - the design of structural elements to safely and efficiently resist the forces and loads

Design Loads: often dictated by building codes

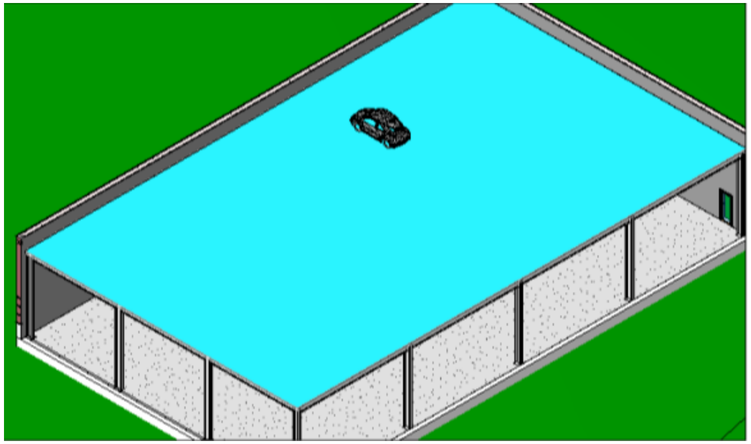
- The load that is assumed for the design of a structure
- May include one or more of the following:
  - Dead Load
  - Live Load
  - Snow and Ice Load
  - Rain Load
  - Flood Load
  - Wind Load
  - Earthquake Load
  - Earth Pressure Load

Load Types

Uniformly Distributed Load

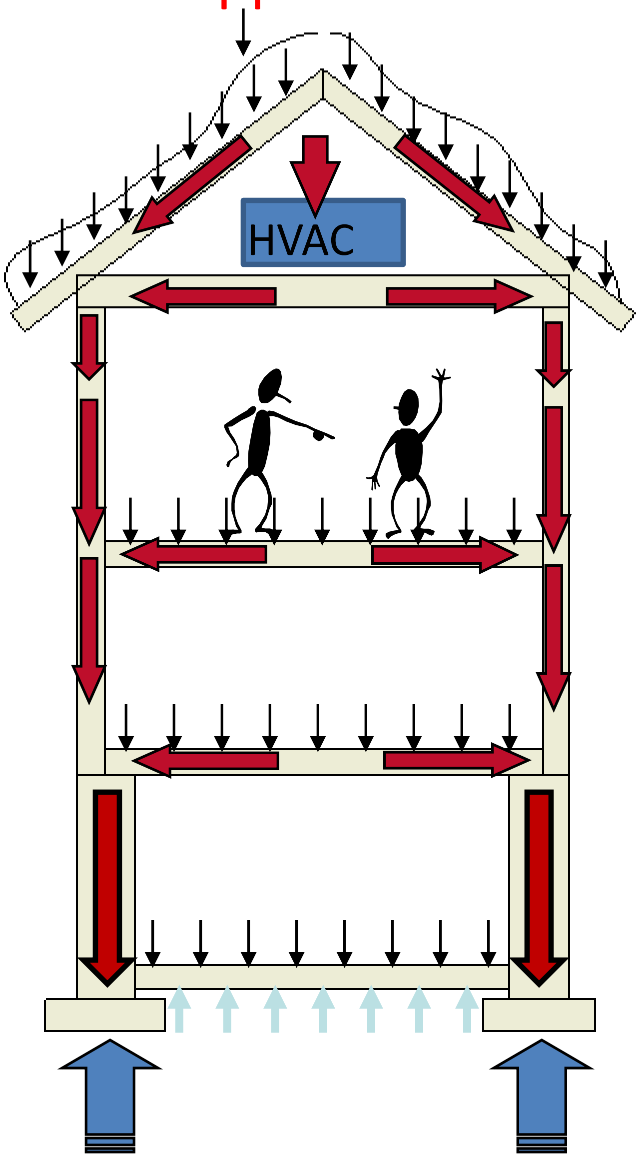


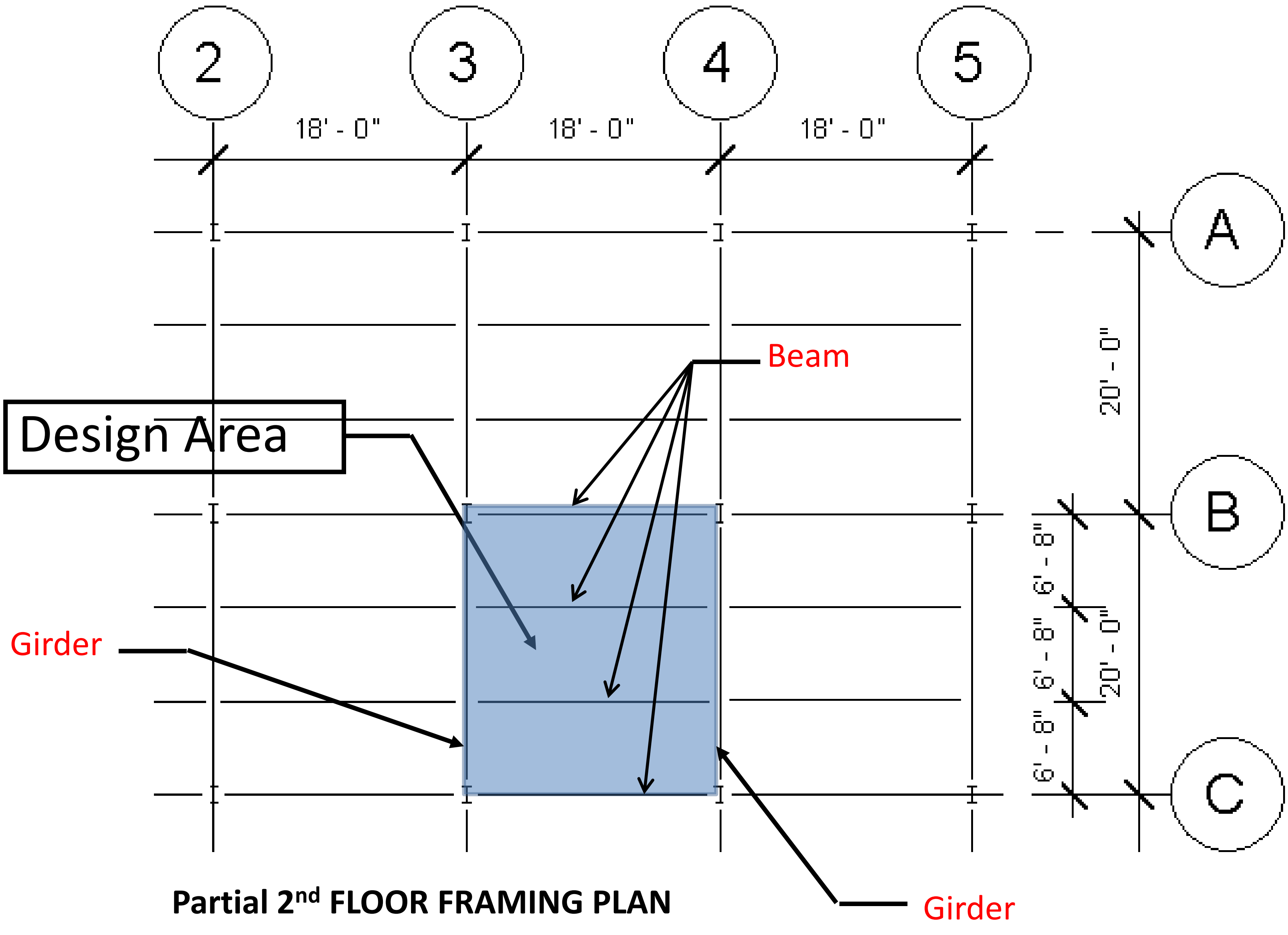
Concentrated Load



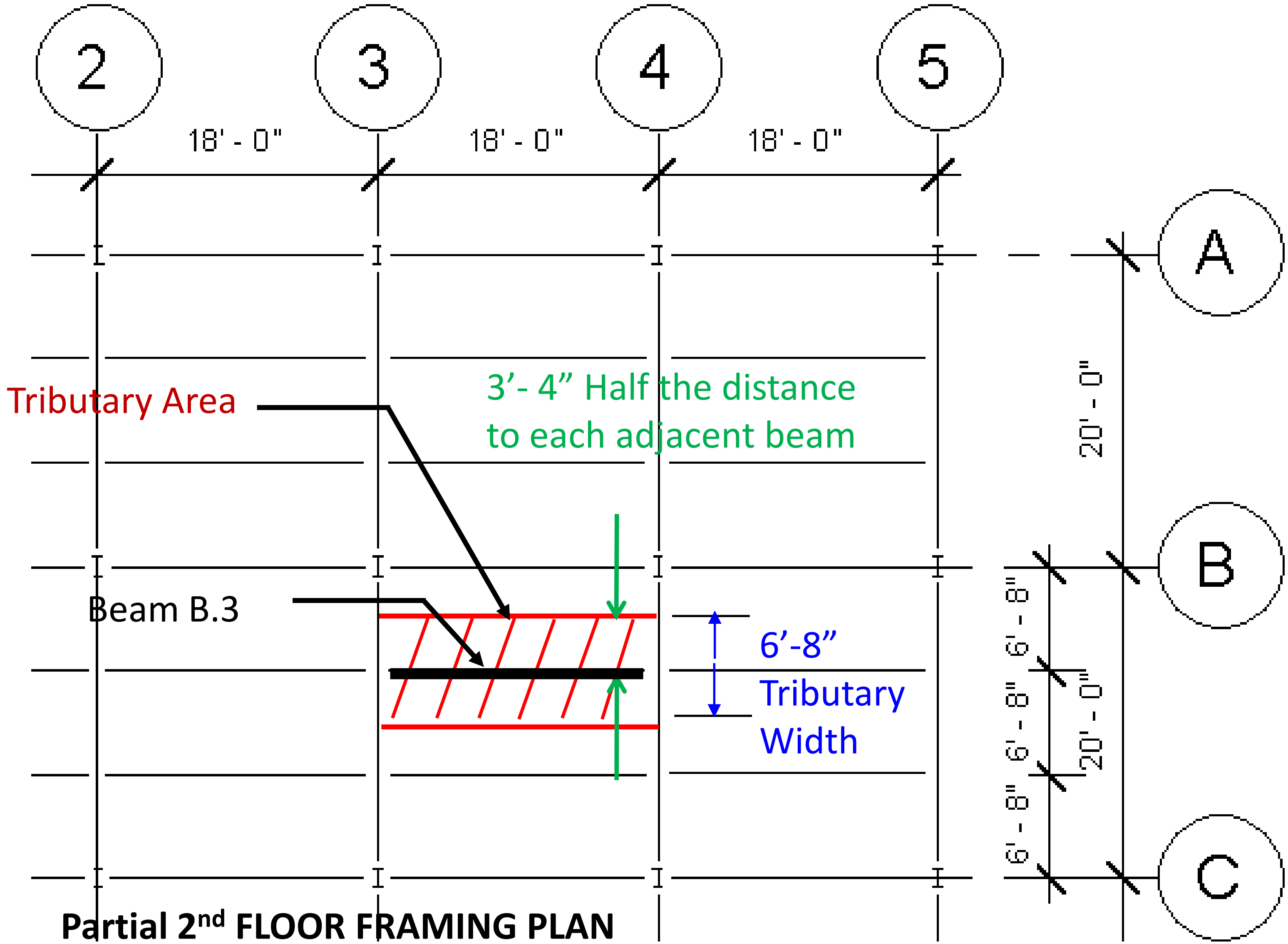
Load Path: structural design includes determination of how structures disperse the applied loads

- The path that a load travels through the structural system
- “Tracing” or “chasing” the loads
- Each structural element must be designed for all loads that pass through it



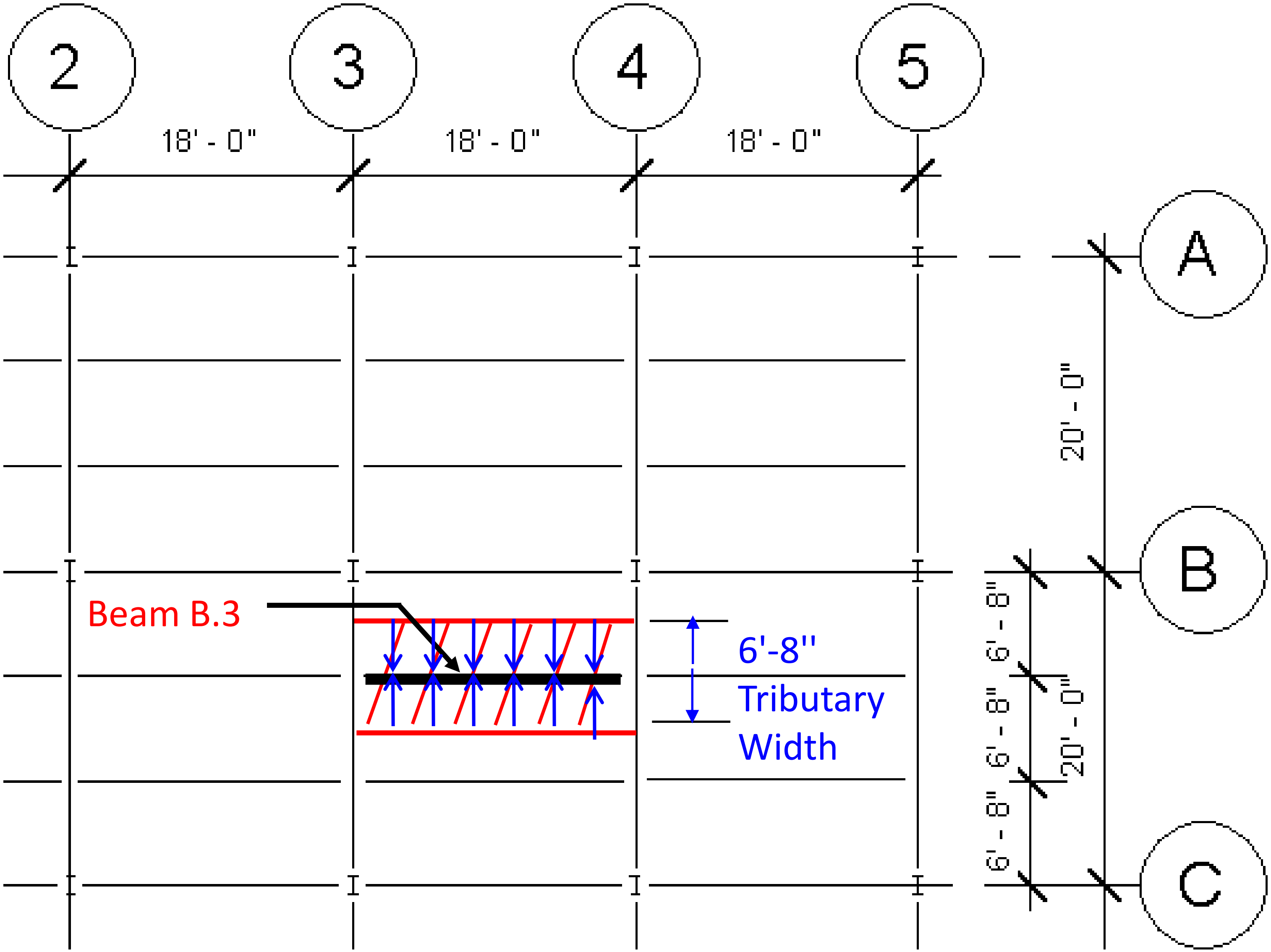


Partial 2nd FLOOR FRAMING PLAN



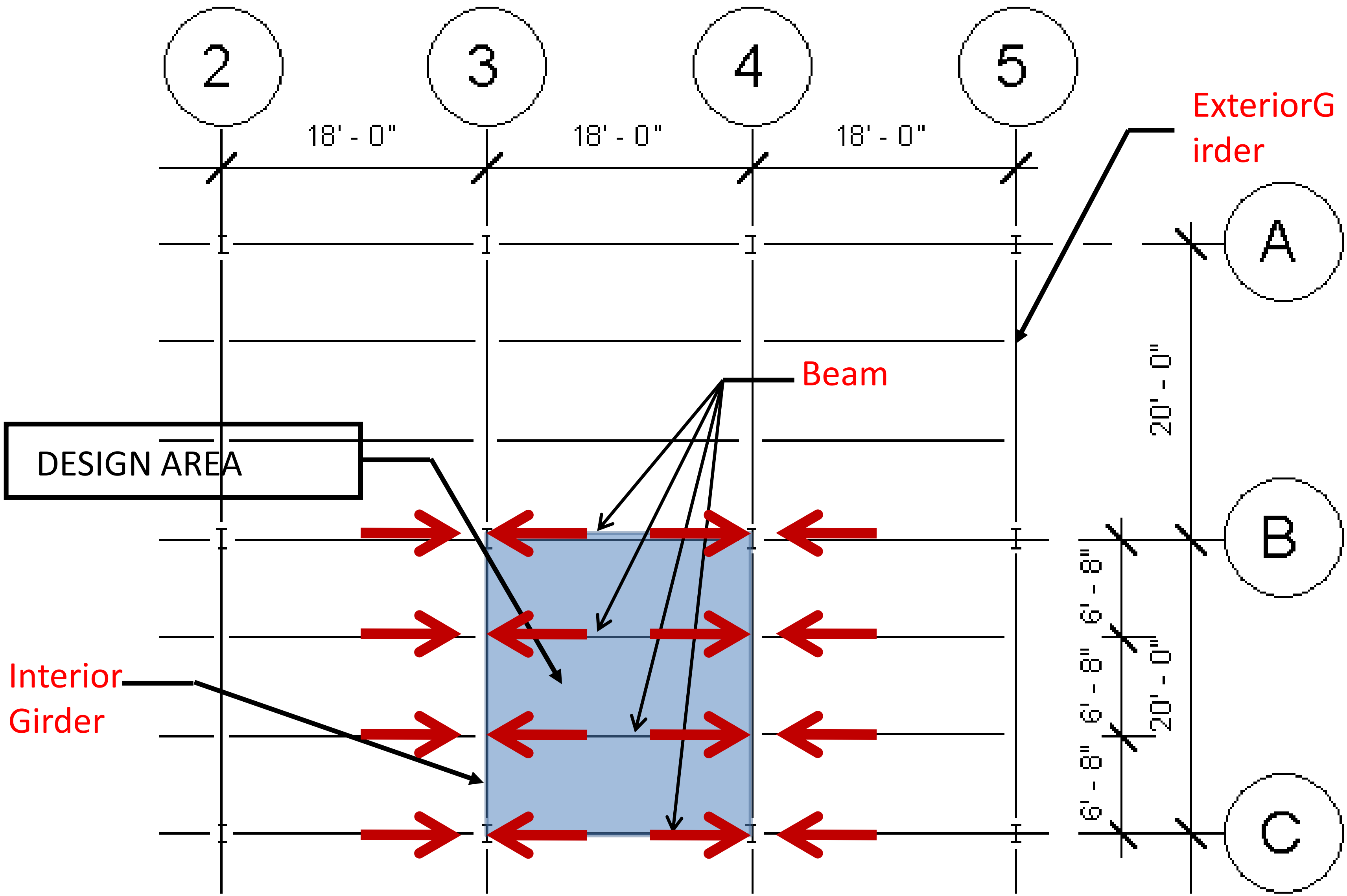
Partial 2nd FLOOR FRAMING PLAN

Tributary Area = Beam Span (length) x Tributary Width



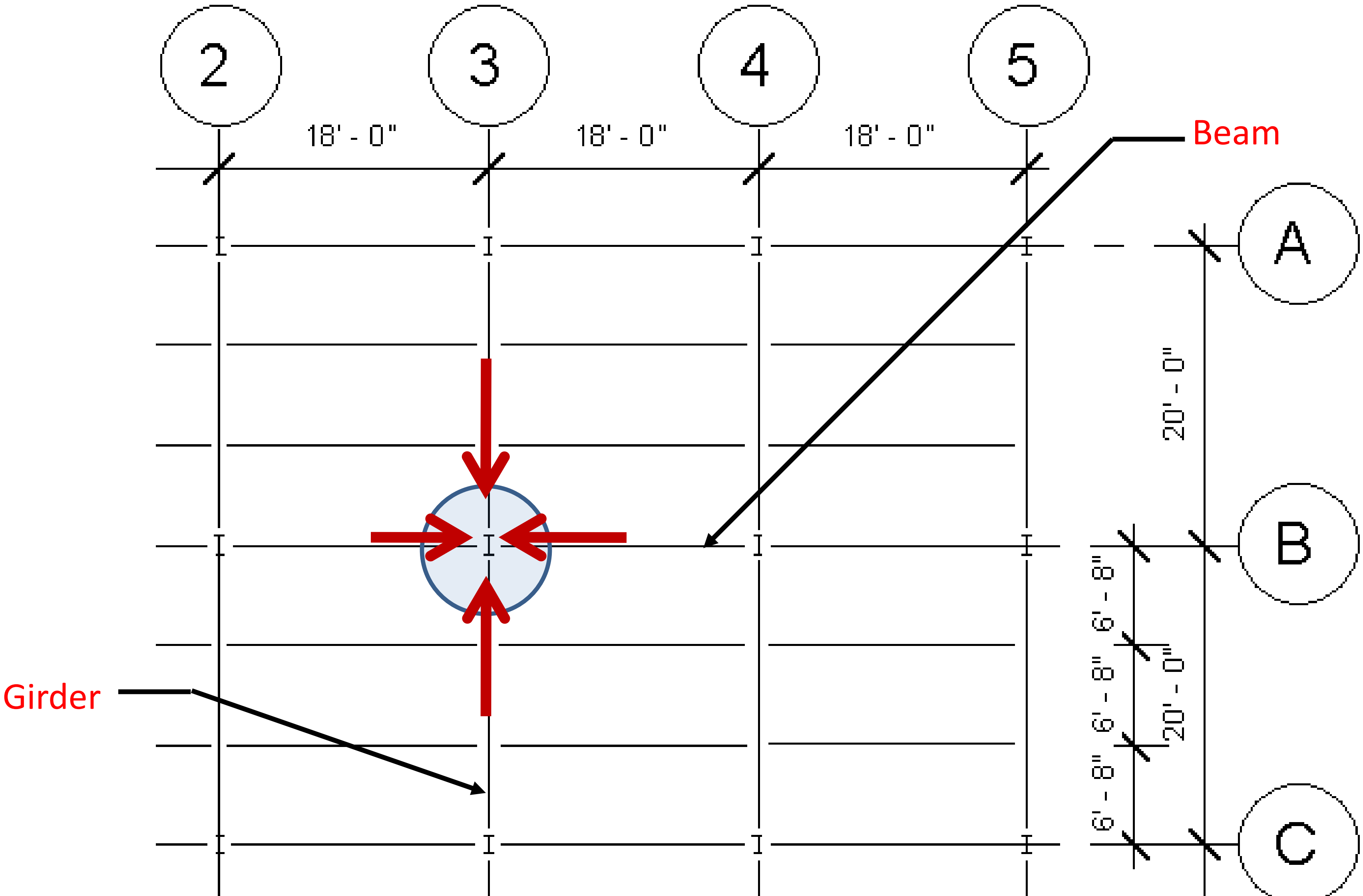
Beam Uniform Load = Floor Loading (psf) x Tributary Width (ft)

Calculating Girder Loading

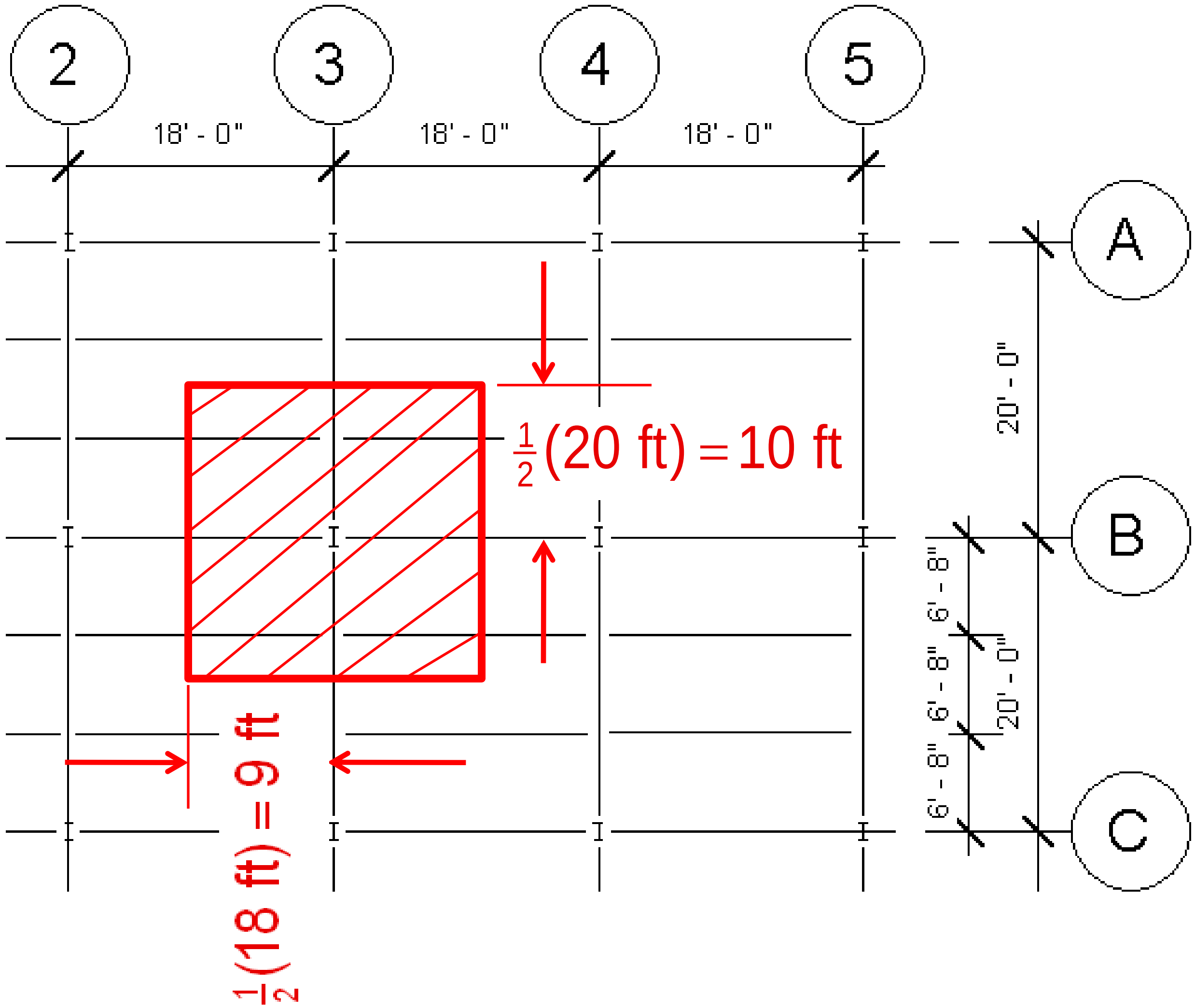


Partial 2nd FLOOR FRAMING PLAN

Calculating Column Loads

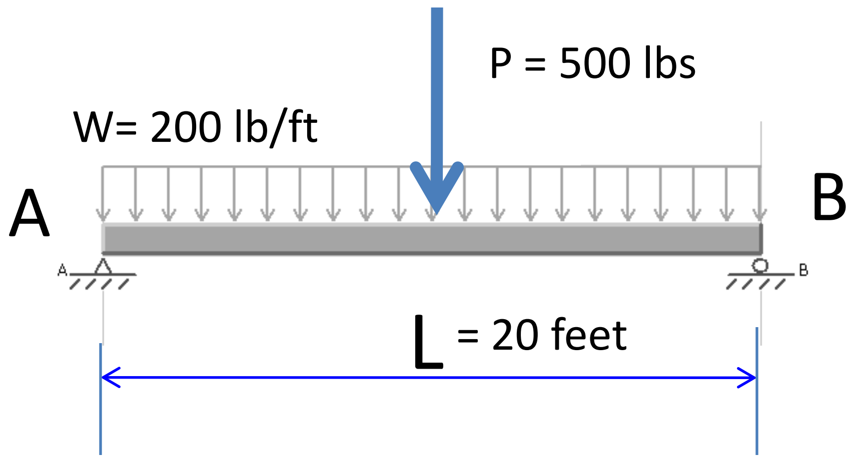


Calculating Column Loads



Tributary Area = (18 ft)(20 ft) = 360 ft^2

Beam Formula Example



Beam Diagram

$$R_A = R_B = \frac{P}{2} + \frac{\omega L}{2}$$

$$M_{max} = \frac{PL}{4} + \frac{\omega L^2}{8}$$

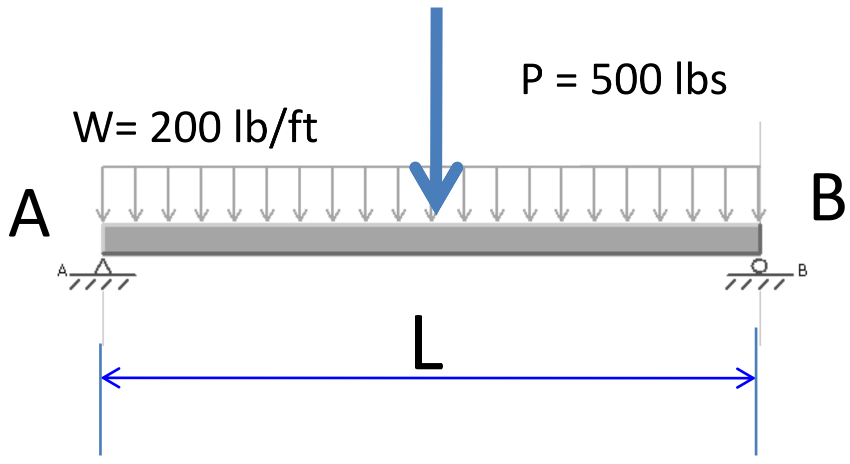
(at point of load)

$$\Delta_{\max} = \frac{PL}{4} + \frac{5\omega L^4}{384EI}$$

Calculate reactions, maximum moment, and minimum section modulus

(at center)

Beam Formula Example



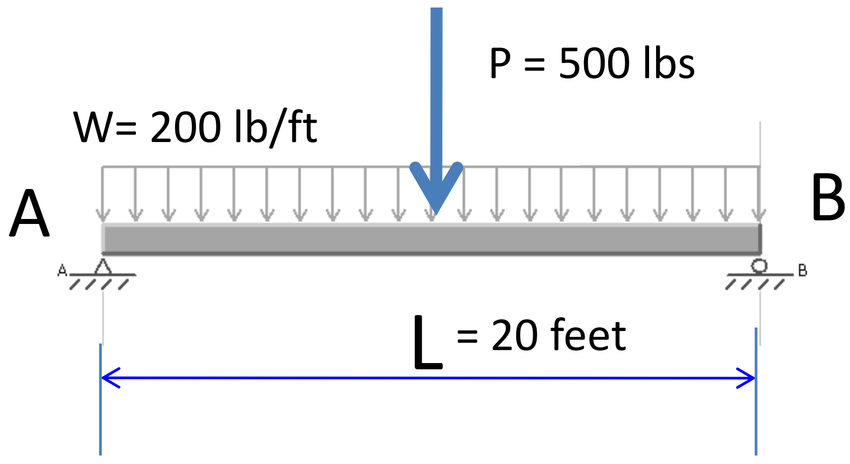
Beam Diagram

$$R_A = R_B = \frac{P}{2} + \frac{\omega L}{2}$$

= 500 lbs / 2 + 200 lb/ft * 20 feet/2
= 250 lbs + 2,000 lbs
= 2,250 lbs

Calculate reactions, maximum moment, and minimum section modulus

Beam Formula Example



Beam Diagram

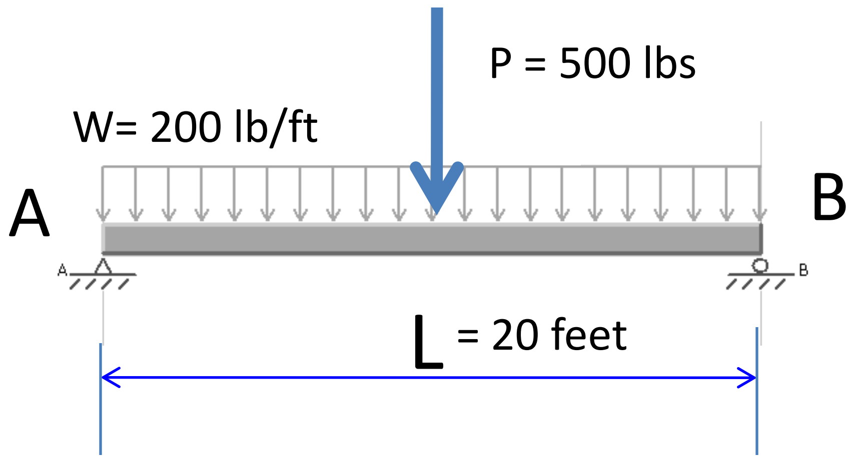
$$M_{max} = \frac{PL}{4} + \frac{\omega L^2}{8}$$

(at point of load)

M max =
500 lbs * 20 ft/4 + 200 lb/ft*(20ft)^2 /8
= 2500 lb-ft + 10,000lb-ft
= 12,500 lb-ft

Calculate reactions, maximum moment, and minimum section modulus

Beam Formula Example



Beam Diagram

M max = 12,500 lb-ft

$$M_n \geq M_a \Omega_b$$

Ω_b = 1.67

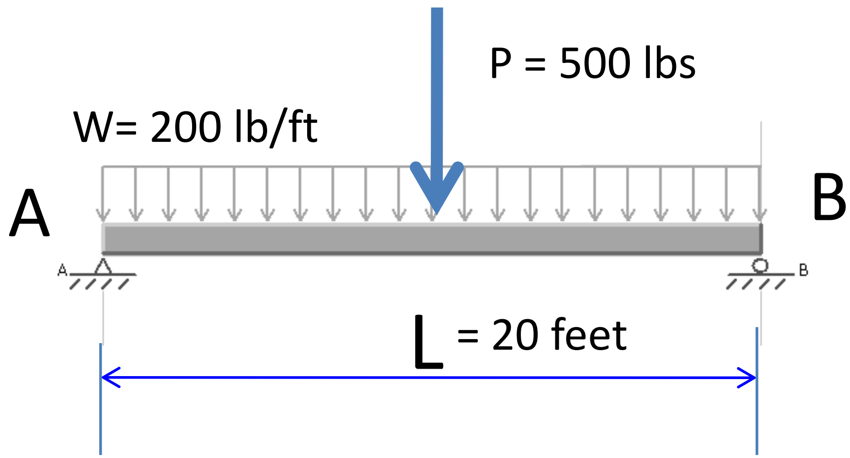
M_n = nominal bending moment strength

M_a = actual moment due to loads

Calculate reactions, maximum moment, and minimum section modulus

Beam Formula Example

Fy = 60, 000 psi



Beam Diagram

M max = 12,500 lb-ft

$$M_n \geq M_a \Omega_b$$

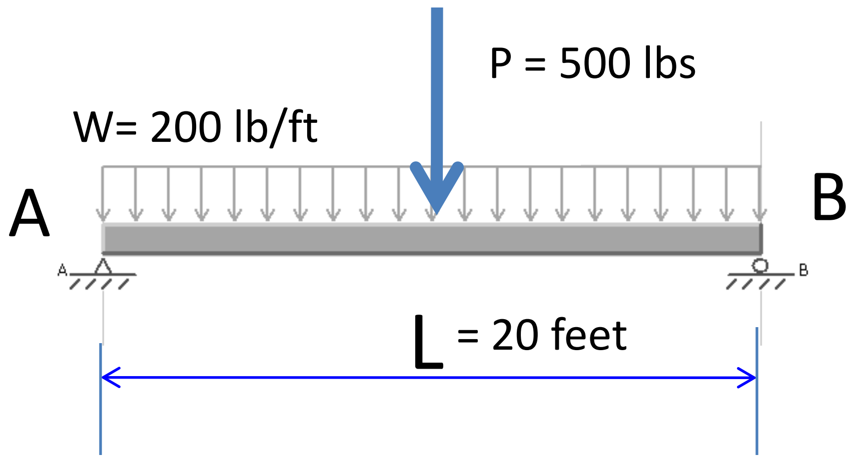
M_n >= 1.67 * 12,500 ft-lb
>= 20,875 ft-lb

Calculate reactions, maximum moment, and minimum section modulus

M_n = FyZx

Beam Formula Example

Fy = 60, 000 psi



Beam Diagram

M max = 12,500 lb-ft

$$M_n \geq M_a \Omega_b$$

FyZx >= 20,875 ft-lb

Zx >= 20,875 ft-lb* 12 in/ft/60,000 psi

Zx >= 4.175 in^3

Calculate reactions, maximum moment, and minimum section modulus

Soil Bearing Pressure

$$q = \frac{P}{A}$$

Where q = Soil bearing pressure

P = Load applied

A = Area of the footing

Soil Bearing Capacities

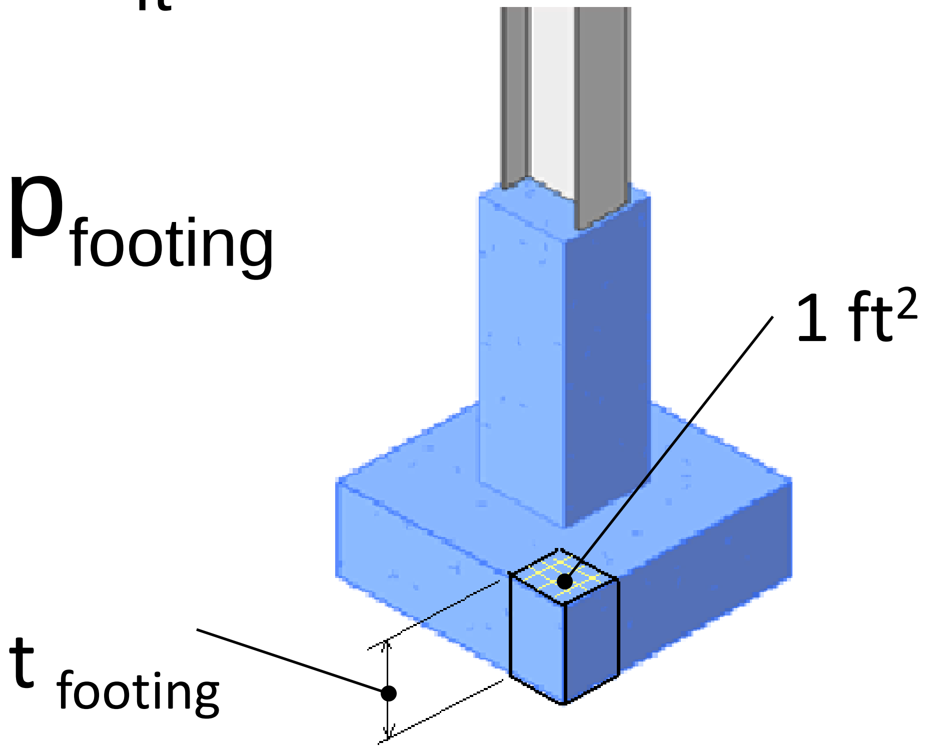
Soil Type	Allowable Soil Bearing (lb/ft ^{2})	Drainage
BEDROCK	4,000 to 12,000	Poor
GRAVELS	3,000	Good
GRAVELS w/ FINES	3,000	Good
SAND	2,000	Good
SAND W/ FINES	2,000	Good
SILT	1,500	Medium
CLAYS	1,500	Medium
ORGANICS	0 to 400	Poor

Net Allowable Bearing Pressure

$$p_{footing} = t_{footing} \cdot 150 \frac{lb}{ft^3}$$

$$q_{net} = q_{allowable} - p_{footing}$$

$$A \geq \frac{P_{column}}{q_{net}}$$



Required Footing Area

Using Net Allowable Soil Bearing Pressure

$$A \geq \frac{P_{column}}{q_{net}}$$

Footing Example

Design a circular footing to the next 4 inch radius increment if:

- Floor Dead Load =40 lb/ft2
- Floor Live Load =100 lb/ft2

Tributary Floor Area Carried by Footing = 50 ft x 60 ft

Allowable Soil Bearing Capacity 3,500 lb/ft2

Assume thickness of footing is equal to 1’-6”

Weight of concrete is 150 lb/ft3

$$A \geq \frac{P_{column}}{q_{net}}$$

Footing Example

P = load = (DL + LL) * tributary area
P = (140 psf) * 50 ft * 60 ft
P = 420,000 lbs

$$q_{net} = q_{allowable} - p_{footing}$$

Q net = 3500 psf – (1.5 feet * 150 pcf)
Q net = 3200 psf

$$A \geq \frac{P_{column}}{q_{net}}$$

A > 420,000 lbs/3200 psf
A> 131.25 ft^2

Area of a circle = pi
131.25 > 3.14 * r^2
6.46 > r

Size to nearest 4 inch increment: 6 feet 8 inch radius

Services and Utilities

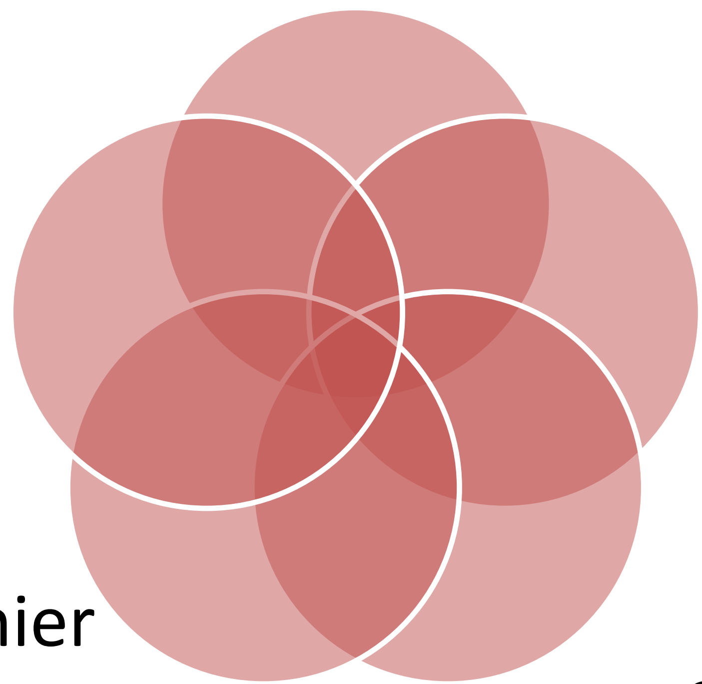
Goal of Energy Codes

Energy codes dictate the **minimum** requirements for the building envelope, lighting, mechanical systems and service water heating

Conserve Natural Resources

Services and utilities must be properly sized to minimize cost and appropriately serve the project

Reduce Costs



Save the Environment

Create Healthier Living Spaces

Preserve Ozone Layer

Internal systems

- Design of internal systems is **documented with construction drawings** specific to each system

Site

Types of Surveys

Land surveying is used for many purposes during the design and construction of a project

- Control Survey: set control points
- Topographic Survey: elevations
- Property Survey: boundaries
- Site Survey: location of project features
- Construction Survey

Calculate the closure error for the differential survey notes below.

					STADIA		
PT	(+) BS	HI	(-) FS	ELEV	TOP/BOT	DIST	Angle
BM	10.53 ft			1025.65 ft	10.87/10.21		
TP1	2.41 ft		11.76 ft		2.75/2.16		
TP2	4.21 ft		1.33 ft		5.03/3.48		
BM			4.04 ft		3.67/2.59		

Closure Error:
Is this error acceptable?

BM: benchmark: known elevation and height
TP: turning poing
BS: backsight
HI: height of instrument HI = BM + BS
FS: foresight
Elev: Elev = HI - FS
Stadia: readings of top and bottom of stadia
Dist (top stadia - bottom stadia) * 100

Stormwater Runoff

- Surface conditions and topography of a site affect the quantity and quality of storm water runoff and the design of the storm water system

Size of Storm Water Ponds

- Rule of thumb: Reserve ten percent of development area for storm water pond
- Volume of storm water *estimate*

$$V = \frac{0.2\ \text{acres} \cdot \text{ft}}{\text{acres}} \cdot A$$

V= Volume of storm water in acre ft

A = Drainage area (area of site) in acres

Size of Storm Water Ponds

- Area of pond

$$A_p = \frac{V}{d}$$

A_p= Area of pond

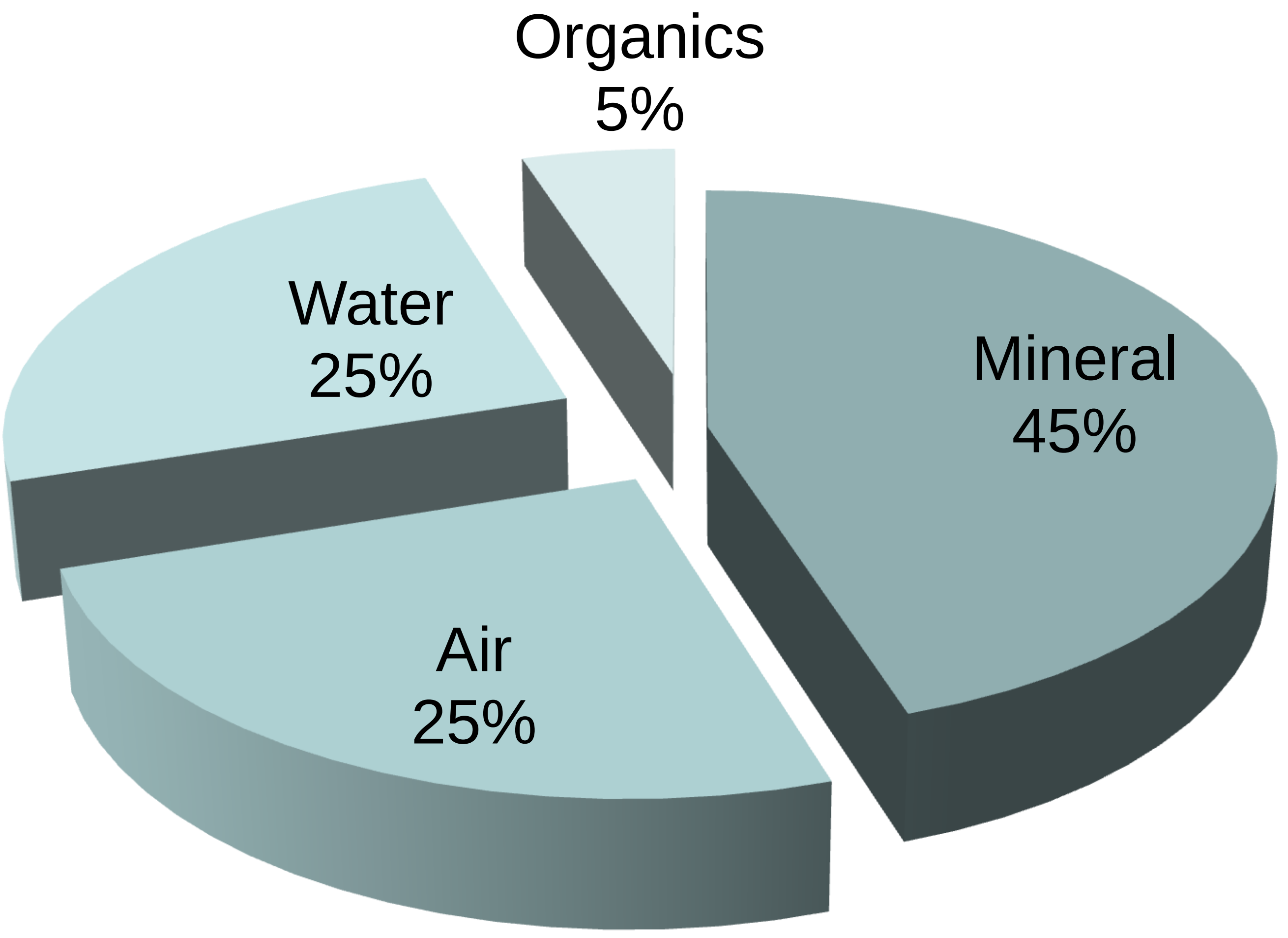
V = Storm water volume in acre ft

d = Average depth of pond

Parking lot Design Considerations

- Ingress and Egress
- Number of Parking Spaces
- Size of Parking Spaces
- Accessibility
- Aisle Width
- Pedestrian Circulation
- Special Vehicle Access
- Off-Street Loading Area
- Waste Disposal
- Drainage
- Landscaping
- Lighting

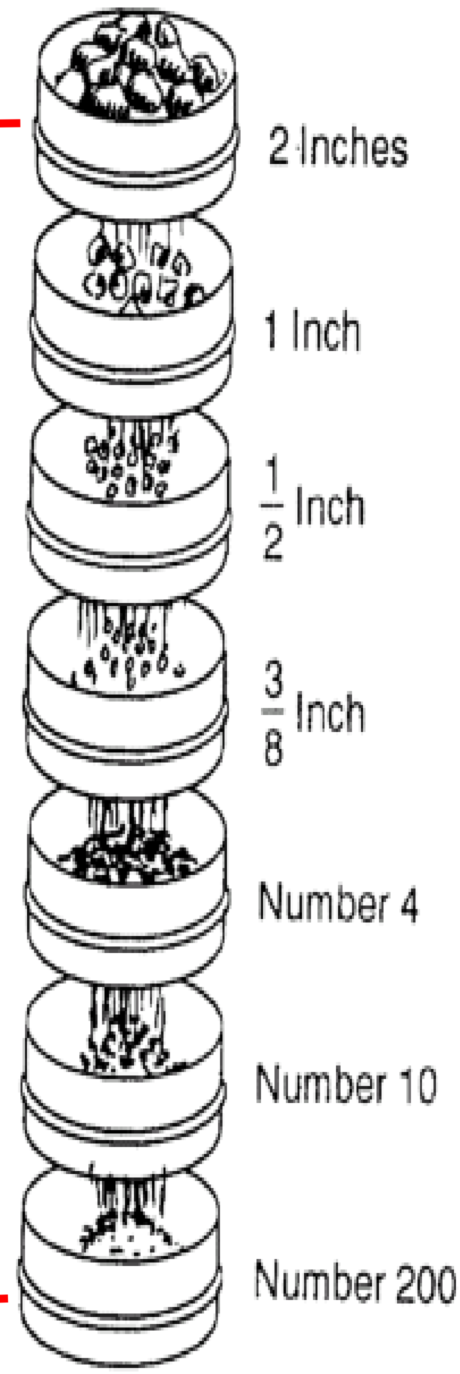
What Is Soil?



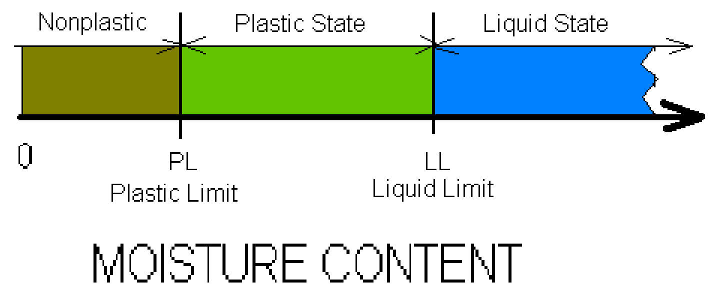
Sieve Analysis

Gravels range from 3 inches down to the size of peas

Silt and clay can pass through the #200 sieve



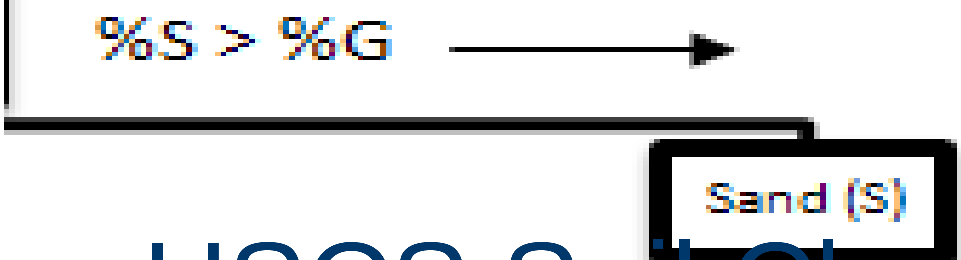
Plasticity



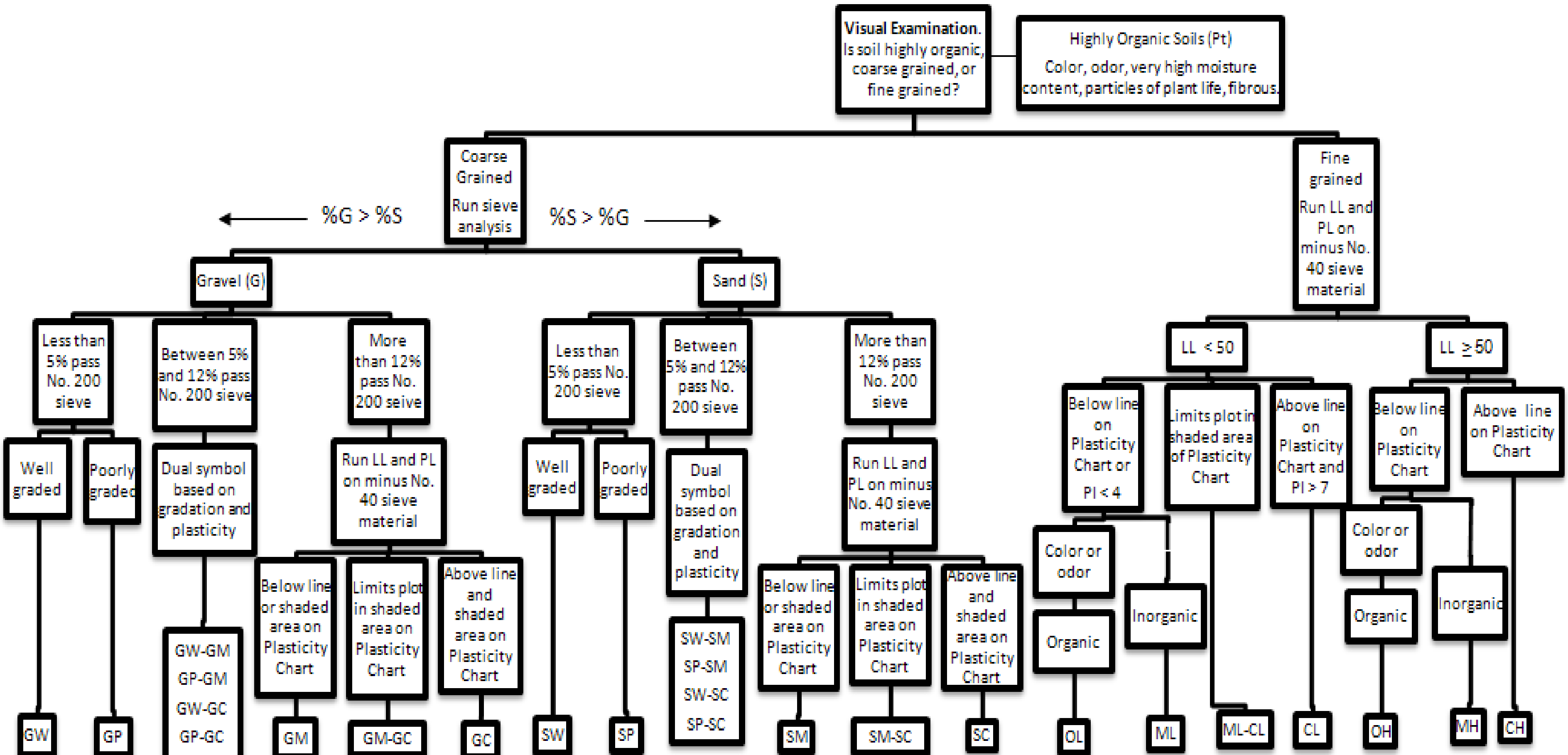
In lieu of dry strength, dilatancy, and toughness, ATTERBERG LIMITS can be used to classify fine-grained soils.

- Plastic Limit (PL) – lowest moisture content at which soils can be rolled into 1/8 in. dia. thread without breaking
- Liquid Limit (LL) – minimum moisture content at which soil will flow when a small shear or cutting force is applied
- Plastic Index (PI) – difference between the LL and PL

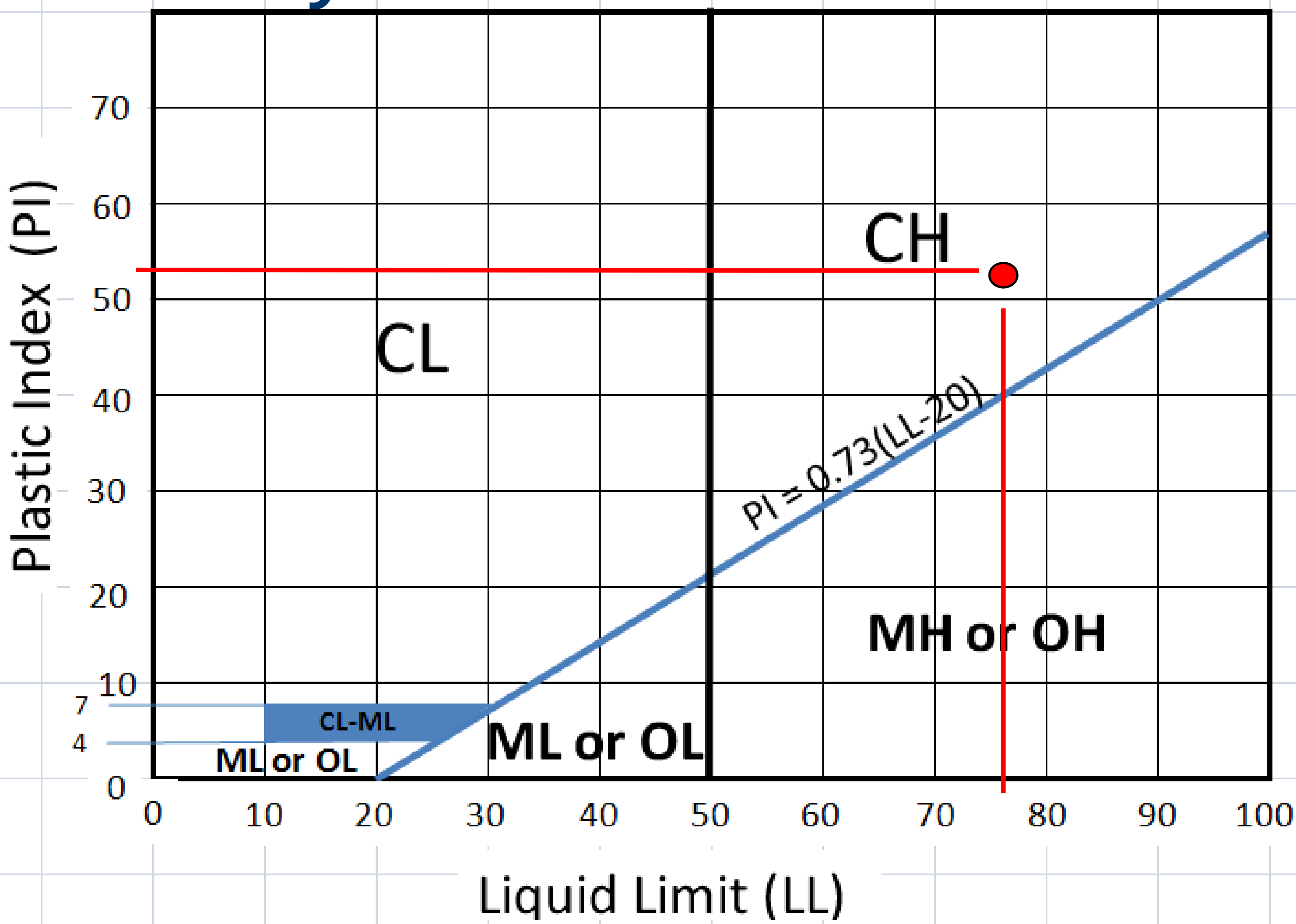
$$PI = LL - PL$$



USCS Soil Classification Chart



Plasticity Chart



Soil Classifications for Foundations

- Sand and gravel – *Best*
- Medium to hard clays – *Good*
- Soft clay and silt – *Poor*
- Organic silts and clays – *Undesirable*
- Peat – *No Good/Avoid*

Characteristics of soil present on site impact the design and construction of improvements to a property

Item	Weight, g
No 4	221.6
No 40	200.3
Pan	290.5
Jar	188

Item	Weight, g	Soil Weight, g
No 4 and retained soil	241.6	[redacted]
Gravel	[redacted]	
No 40 and retained soil	365.5	[redacted]
Med and coarse sand	[redacted]	
Bottom pan and soil	412	[redacted]
Fine Sand, Silt, Clay	[redacted]	

Fill in the blanks

Item	Weight, g	Fraction in jar	Soil Sample weight, g
jar and soil	263.9	[redacted]	[redacted]
jar and sand	233.4		
soil in jar			
fine sand in jar			
silt and clay in jar			
fine sand in pan	[redacted]	[redacted]	
silt and clay in pan			

Item	Weight, g
No 4	221.6
No 40	200.3
Pan	290.5
Jar	188

Item	Weight, g	Soil Weight, g
No 4 and retained soil	241.6	[redacted]
Gravel	[redacted]	20
No 40 and retained soil	365.5	[redacted]
Med and coarse sand	[redacted]	164.9
Bottom pan and soil	412	[redacted]
Fine Sand, Silt, Clay	[redacted]	121.5

Item	Weight, g
jar and soil	263.9
jar and sand	233.4
soil in jar	75.9
fine sand in jar	45.4
silt and clay in jar	30.5
fine sand in pan	[redacted]
silt and clay in pan	[redacted]

Fraction in jar
[redacted]
0.6
0.4
[redacted]

Soil Sample weight, g
[redacted]
72.9
48.6

Fill in the blanks:

If the soil has a LL of 65 and a PL of 20, what type of soil is this?

Item	Soil Sample Weight, g	Percent in soil sample
Gravel		
Med and Coarse sand		
Fine sand		
Silt and clay		

Sieves

4

40

Fill in the blanks:

If the soil has a LL of 65 and a PL of 20, what type of soil is this?

Item	Soil Sample Weight, g	Percent in soil sample	Sieves
Gravel	**20**	**6.5**	
			4
Med and Coarse sand	**164.9**	**53.8**	
			40
Fine sand	**72.9**	**23.8**	
Silt and clay	**48.6**	**15.9**	

PI = LL – PL
PI = 65 – 20
PI = 45

15.9 % pass 200 so 84.1 % retained on 200 sieve
% S > % G
15.9% pass #200
Plots below line
Therefore SM or sandy silt